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# SECOND WORKING MEETING ON METEOROLOGICAL AND DIFFUSION CHARACTERISTICS IN WOODED AND URBAN DOMAINS IN COMPLEX TERRAIN

Willy Z. Sadeh, et al.

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# SECOND WORKING MEETING ON METEOROLOGICAL AND DIFFUSION CHARACTERISTICS IN WOODED AND URBAN DOMAINS IN COMPLEX TERRAIN

December 1983

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US Army Electronics Research and Development Command
**Atmospheric Sciences Laboratory**
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On 30 and 31 March 1983, the Pacific Southwest Forest and Range Experiment Station in Riverside, California, conducted a second working meeting on meteorological and diffusion characteristics in wooded and urban domains. The second meeting addressed the planning for a cooperative field study needed to create a comprehensive meteorological data base in wooded and urban domains in complex terrain. Such a data base is needed for developing, testing, evaluating, and validating integrated mesoscale-microscale models. The meeting

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20. ABSTRACT (continued)
resulted in the agreement on the organizational structure for field study, the selection of a 200 km on a side area centered on Sacramento, California, as the site for the study, the establishment of guidelines to be followed in preparing the work plan for the study, and a draft supplemental agreement between the Army and the Forest Service.

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## EXECUTIVE SUMMARY

The scientific objectives, planning, design and workplan of the cooperative field study on meteorological and diffusion characteristics in wooded and urban domains in complex terrain, the selection of a field site, the organizational structure of the project, and the supplemental agreement on the cooperation between the US Army Atmospheric Sciences Laboratory and the US Forest Service were addressed by the Second Working Meeting. A consensus was reached to conduct the cooperative field study in Sacramento area, California, within a site of 200 km on the side. A management and organizational structure consisting of: a policy committee; a project manager; working groups on canopy domain, urban domain, complex terrain and dispersion; field coordinators on canopy, urban, complex terrain and dispersion; a data management committee; a meteorological modeling evaluation committee; and, a dispersion modeling evaluation committee was established. Members of the policy committee, chairman and members of the scientific-technical committee, and chairman of the four working groups were appointed. The working groups were charged to complete proposals on the specific scientific objectives, planning, design and workplan of the corresponding components of the joint field study according to the guidelines set forward in the First and Second Working Meetings. Integration of these proposals into a unified proposal will be accomplished by the Scientific-Technical Committee. A Supplemental Agreement acceptable to both agencies was drafted. A Third Working Meeting will convene at Forest Pest Management Office in Davis, California, on 15-17 November 1983. The main goal of this meeting is to finalize and approve the unified proposal on the cooperative field study.

## 1. INTRODUCTION

The second working meeting on meteorological and diffusion characteristics in wooded and urban domains in complex terrain was conducted at the Pacific Southwest Forest and Range Experiment Station (PSWF&RES) in Riverside, California, on 30 and 31 March 1983. This second meeting was convened according to the work plan adopted in the first working meeting. A summary report on the First Working Meeting, which was held at Atmospheric Sciences Laboratory in White Sands, New Mexico, on 16 and 17 November 1982, was published as an ASL report, ASL-CR-83-8035-1, January 1983. This report was prepared by the steering committee and it is authored by W. Z. Sadeh, R. M. Cionco and D. G. Fox.

The second working meeting was convened to address the planning of the cooperative field study between the Atmospheric Sciences Laboratory (ASL) and the Forest Service (FS), to establish the organizational structure of this joint effort, and to review the various aspects of the cooperation between the two agencies. Specifically, the goals of the second working meeting were to:

(1) review the summary report of the first working meeting;

(2) synthesize the objectives of the cooperative field study into an integrated plan;

(3) select a field site that meets the specified requirements of wooded and urban characteristics in complex terrain;

(4) review the measurement techniques, procedures and instrumentation;

(5) establish the organizational structure of the cooperative field study;

(6) discuss the memorandum of understanding and supplemental agreement concerning the cooperation between the two agencies.

A summary of this second working meeting is reported in this document.

The second working meeting was hosted by PSWF&RES and organized by the steering committee (R. M. Cionco, D. G. Fox and W. Z. Sadeh) in cooperation with M. A. Fosberg (PSWF&RES). A total of fourteen scientists attended the working meeting: seven from Forest Service, six from Army Laboratories, and one from Colorado State University. The roster of the participants is given in Appendix I.

The second working meeting lasted for two days, and the agenda is given in Appendix II. During the morning of the first day six general briefings were delivered. In the afternoon of the first day, the discussion focused on the scientific and applied objectives of the field

study, and on the selection of a field site. The second day was devoted to general discussion on resources and measurements and, in particular, on the management, organizational structure, technical working groups, and the supplemental agreement of mutual assistance between the Forest Service and the Army.

## 2. GENERAL BRIEFINGS

In the first session on 30 March 1983, the following six general briefings were delivered: C. W. Philpot presented an overview on Forest Service organization and activities; R. M. Cionco reviewed the objectives of the cooperative field study; W. Z. Sadeh reported on the steering committee activities; E. H. Holt, J. D. Wood and W. T. Sommers reviewed the reaction to the proposed cooperative field study of Atmospheric Sciences Laboratory, Chemical Systems Laboratory and Forest Service, respectively. No attempt is made here to include the entire briefings. The major points of these briefings are briefly outlined below to provide a general overview.

### 2.1 Forest Service Organization and Activities, C. W. Philpot, PSWF&RES

Philpot, to start with, welcomed the participants to the second working meeting in Riverside. Next, he briefly outlined the organizational structure of the Forest Service, an agency within the Department of Agriculture. The Forest Service consists of three primary branches: National Forest System, State and Private Forestry, and Research Branch. National Forest System manages about 195 million acres of federal land and it is in charge of commodity forest products. As a result, this branch is the revenue producing part of the Forest Service. State and Private Forestry branch is in charge of state and private forest programs such as long-term investment in forestry, fire suppression, and other related programs. Federal support for this branch is matched by state and landowner funds. The forestry research branch consists of eight experiment stations geographically distributed across the country. This branch is federally chartered to conduct research on federal, state and private wildland, and also participates in international programs. The research is mainly conducted in support of the National Forest System. In addition, research for the Bureau of Land Management, National Park Service, the State of California, and private corporations is also conducted. Inherently, the forestry research is primarily mission oriented and applied in view of the charter of the Forest Service. Basic research amounts, at this time, to about 20 to 30% of the research activities of the research stations. Forest Service is a very decentralized organization. Each region within the National Forest System, each area within the State and Private Forestry, and each experiment station within the Research Branch are locally managed within the overall structure of the Forest Service.

Philpot next pointed out that forest meteorology and air quality research programs are conducted by two major work units that are located in the Rocky Mountain Experiment Station, Fort Collins, Colorado, and Forest Fire Laboratory, Riverside, California, Pacific Southwest Experiment Station. The research projects performed by these two meteorological units focuses on wind modeling, diffusion modeling, field studies, air quality problems, and other topics of interest. These projects are of regional and national nature. In addition to these two major programs, there are work units across the country that concentrate on local meteorological problems.

Research on forest fire is conducted at three national laboratories within the Forest Service. These three national laboratories are: (1) Southern Forest Fire Laboratory, Southeastern Experiment Station, Macon, Georgia; (2) Northern Forest Fire Laboratory, Intermountain Experiment Station, Missoula, Montana; and, (3) Forest Fire Laboratory, Pacific Southwest Experiment Station, Riverside, California. He further briefly outlined the research being conducted in these three national laboratories. In Macon, the research deals primarily with fire management in the southeastern part of the country. In Missoula, the research focuses on fire suppression, fire retardants, behavior and modeling. In Riverside, a wide spectrum of forest fire research topics are covered with emphasis on fire planning and economics. As far as the Washington Office is concerned, a unit on Forest Fire and Atmospheric Sciences Research operates as a part of the Staff of the Deputy Chief for Research.

Philpot next stated that the Forest Service supports the realization of the proposed cooperative field study with the Atmospheric Science Laboratory since the meteorological needs of both agencies are identical. He further emphasized that there is a long history of successful cooperation between the Forest Service and agencies of the Department of Defense. As far as the proposed cooperative field study is concerned, Philpot stressed the need for a sound balance between the data gathering and the scientific objectives. Data gathering per se without bearing in mind the basic science is useless and, hence, due attention must be paid to conduct the data collection according to clearly established scientific guidelines. Another aspect stressed by Philpot was the organization and management of the cooperative field study. He pointed out the need for establishing an efficient organizational structure and management so that to ensure the successful completion of the cooperative field study. Finally, Philpot stated that the Forest Service Experiment Stations that will be involved in the cooperative field study are: Pacific Southwest, Riverside, California; Rocky Mountain, Fort Collins, Colorado; Pacific Northwest, Portland, Oregon; and Intermountain, Missoula, Montana. In addition, the Forest Pest Management unit in Davis, California, will participate in this joint effort.

## 2.2 General Remarks, R. M. Cionco, Atmospheric Sciences Laboratory

Cionco first recognized the presence of the management of the agencies involved (FS, ASL, CSL) at the meeting as a clear indication of support for the cooperative field study. Next, he briefly reviewed the charges to the Steering Committee resulting from the First Working Meeting. To date, the Steering Committee tackled the following tasks: (1) documentation of the First Working Meeting by an ASL report; (2) evaluation of the suggested eight field sites; (3) organization of the present Second Working Meeting; (4) drafting of a tentative memorandum of understanding on the cooperation between the two agencies; (5) tentative organizational structure of the cooperative effort; and, (6) development of communication links among the various parties interested in the cooperative study.

Subsequently, Cionco reviewed the need for the generation of a database according to the requirements and within the time frame proposed in the First Meeting. This unique database is needed for validation and improvement of models and for integration of micro-meso scale models in vegetative and urban domains in complex terrain. The evolution of the concept of a cooperative field study was outlined. Such a joint effort is economical and practical and its feasibility is evident. The mutual needs of ASL and FS are primarily confined to vegetative and canopy domains. As far as the urban domain is concerned, this task represents an objective of specific concern to ASL.

Cionco next pointed out that the field study concentrates on meterological and diffusion parameters. The meteorology exists independent of diffusion whereas the opposite is not true. Furthermore, the meteorology is the input for any diffusion modeling. Therefore, the emphasis is to be placed on the meteorology. Moreover, a diffusion field study, including dispersion, short- and long-range transport, is a much bigger and expensive project.

The micro amd meso scales of interest and the associated data point resolution were next briefly reviewed so that to establish the overall dimensions of the field site. At the same time, the inherent ambiguity associated with defining these scales was stressed. Spatial micro scales of interest in canopy and/or vegetative and urban domains are about 50 m in the vertical direction and several kilometers (1 to 10 km) in the horizontal direction. Data point resolution of 100 m is desired in view of the present status of modeling. Time scales of the order of minutes to a day including both daytime and nighttime airflow situations are of interest. The mesoscale of interest is within both the surface layer and the planetary boundary layer. Suggested meso scales are 1 km in the vertical direction and about 100 to 200 km in the horizontal direction. At this time, it is apparent that an area of 200 km on the side is desired. As far as data point resolution is concerned, it is suggested to start with middle gross resolution of about 1 to 20 km. Subsequently, one can focus on a smaller area of about 5 km on the side with a finer resolution of about 100 m. Essentially, these resolutions are in agreement with the nesting of the micro models within the meso models. Cionco further emphasized that ASL is interested in the finer resolution and in point prediction of wind and temperature. Next, he pointed out that he views a regional scale as that defining a domain of roughly similar surface roughness such as a cornfield or tree stands. A clearing within a canopy can further be viewed as a local scale.

In concluding the presentation, Cionco stressed the need to establish the technical working groups, to complete the MOU, and to follow the timetable of the cooperative field study.

## 2.3 Steering Committee Report, W. Z. Sadeh, Colorado State University

Sadeh first outlined the development of the proposed concept of a cooperative field study between ASL and FS. Historically, Cionco met with Fox and Sadeh in summer 1982 in Fort Collins, Colorado. The purpose of this informal meeting was to examine the feasibility of initiating a cooperative field study devoted to generate a database tailored to the mutual needs of both ASL and FS. It was concluded in this meeting to organize a working meeting of scientists from FS and ASL in Fall 1982 in White Sands Missile Range, New Mexico, in order to explore the concept of a cooperative field study between the two agencies. As a result, the First Working Meeting was held in White Sands from 16 to 17 November 1982.

The objectives of the First Working Meeting were to: define the goals of a cooperative field study, identify the ongoing related research conducted in various laboratories and their capabilities, and outline a preliminary work plan of the joint effort. A unanimous consensus for initiating, organizing and conducting a cooperative field study between the two agencies on meteorological and diffusion characteristics in wooded and urban domains in complex terrain was reached. A steering committee consisting of R. M. Cionco (ASL), D. G. Fox (FS) and W. Z. Sadeh (CSU) was appointed to temporarily coordinate the activities of the proposed joint study. A Summary Report of the First Working Meeting was published as an ASL report (ASL-CR-83-8035-1) in January 1983.

Next, the highlights of the Summary Report of the First Working Meeting were briefly reviewed by Sadeh in order to set the background for the Second Meeting. As far as the various scales are concerned, Sadeh pointed out that regional and local scales are those scales of the horizontal wind energy spectrum corresponding to high frequencies (or large periods). The local scale is of significance in dealing with airflow about a single or several tree elements; airflow around a single building, and ventilation of a building, to mention several situations. Regional scale is characteristic, for instance, to airflow about several tree stands or about a cluster of buildings. Both scales are essentially high-frequency subscales nested within the upper end of the micro range. These scales are of prime significance as far as the resolution of turbulence is concerned.

In further reviewing the Summary Report, Sadeh outlined the proposed organizational structure of the cooperative study. At this point, the proposed structure consists of: (1) Project Director; (2) Policy Advisory Committee: (3) Scientific/Technical Coordination Committee; (4) Technical Working Groups on Field Study, Modeling and Data Management; and, (5) Technical Working Subgroups on Canopy and Urban Domains. An additional Technical Working Subgroup on Complex Terrain is further suggested. The importance of archiving the database in a standard format fully documented was stressed. Essentially, the use of the data for model evaluation and development is contingent upon supplying it in a format readily accessible to the scientists in the two agencies. In completing the review of the Summary Report, Sadeh emphasized that all the recommendations are submitted for discussion and final approval.

At this point, Sadeh further elaborated on the charges to and the activities of the Steering Committee. He presented the survey form that was sent to all the participants in order to collect information concerning involvement in the study, instrumentation availability, and manpower commitment (see Sect. 4).

In concluding the report, Sadeh stressed that the goals of this meeting are to define the specific scientific objectives of the field study, to outline a workplan, to establish a streamlined organizational structure, to appoint the Chairman of the Scientific/Technical Coordination Committee and the Chairmen of the Technical Working Groups, to outline the charges to the Technical Working Groups, and to conclude a memorandum of understanding between the two agencies.

## 2.4 Atmospheric Sciences Laboratory Reaction to the Cooperative Field Study, E. H. Holt, Chief, Atmospheric Research Division

Holt first indicated that ASL fully supports the cooperative field study. This study is of major significance and the ASL management is committed to ensure its realization. Pooling of the resources of the two agencies offers a unique opportunity for the successful completion of this study in an efficient and economical way. In conducting this study, due attention should be paid to the scientific objectives. The ultimate goals of this field study are evaluation, validation, improvement and development of models. Generation of a comprehensive database is needed to meet these basic scientific goals and, hence, the field study must be planned accordingly. The vast experience of ASL in field studies of battlefield obscuration clearly indicates that one always needs to bear in mind the basic scientific objectives. Another aspect of prime concern is the organization of the field study. Attention should be paid to develop a streamlined and efficient organizational structure and management. Otherwise, the successful realization of the cooperative field study cannot be ensured. Next, Holt stressed that the basic ideas and guidelines for the cooperative study are adequately outlined in the Summary Report of the First Meeting. At this time, it is necessary to address the planning of the joint study and to complete the memorandum of understanding between the two agencies.

Next, Holt briefly described the mission and organization of ASL which is a laboratory within the Army Electronics Research and Development Command (ERADCOM). The mission of ASL is to provide atmospheric and meteorological support related to army operation and systems, tactical weather intelligence, atmospheric sensors and other aspects. Essentially, the expertise in atmospheric sciences and meteorology within the Army is concentrated at ASL. In order to meet its mission, the Atmospheric Sciences Laboratory consists of four divisions. The Atmospheric Research division is in charge of basic research and, hence, the cooperative study will be housed in this division.

Airflow scenarios in canopy and urban domains in complex terrain of interest to ASL were next presented. The pressing need to account for the daytime and/or nighttime conditions in modeling the wind and diffusion was clearly revealed by these airflow situations. Modeling of smoke release, obscuration and penetration within a variety of canopy and urban situations is of major tactical importance. In this regard, it is imperative

to adequately account for the surface boundary conditions (surface roughness) in developing realistic models. Coupling of micro-mesoscale models so that to develop unified models is the ultimate aim of the current modeling work being conducted at ASL.

Holt next stressed that the joint study is of critical importance to ASL in view of the intensive research on modeling. Generation of a database is crucial to ensure the credibility of the present models and to foster their improvement. In addition, the database will represent a significant contribution to the atmospheric sciences. As far as the involvement of ASL in the various aspects of the joint study is concerned, Holt indicated that ASL will cooperate with the FS in the canopy domain and complex terrain work. The urban domain is a component of specific interest to ASL and will be conducted by ASL within the context of the joint program.

In summarizing the remarks, Holt further reiterated the commitment of ASL to the cooperative field study and the creation of the longing for database on meteorological and diffusion characteristics in wooded and urban domains in complex terrain.

## 2.5 Chemical Systems Laboratory Reaction to the Cooperative Field Study, J. D. Wood, Chief, Systems Development Division

To start with, Wood briefly outlined the mission and organization of the Chemical Systems Laboratory (CSL) which is under the Army Armament Research and Development Command (ARADCOM). CSL mission is of specific military nature. The major mission of CSL is to provide the Army with the capability to operate in chemical and biological battlefield. A secondary role is the deterrence of chemical attack. CSL has a lead laboratory status within the Department of Defense, and it also conducts basic and applied research and early materiel development for the Navy and Air Force. In addition, CSL is involved in international programs.

CSL work on smoke obscuration technology base systems, large area smoke systems for battlefield, protection systems, detectors and other systems is directly related to modeling of meteorological conditions and diffusion. This naturally led to a close relationship with ASL which constitutes the center of expertise in atmospheric sciences in the Army. The cooperation between ASL and CSL is based on their specific mission and capability. Scientific research is the responsibility of ASL while CSL concentrates on the operational and application aspects. At the same time, CSL follows closely the scientific work of ASL so that to adequately evaluate the application to operational problems.

The meteorology area is housed in the Systems Development Division of CSL, which is responsible for operations research and analytical support. The mission at CSL is structured into ten program areas which were briefly described. Wood further pointed out that some of these ten programs are involved in equipment development in addition to applied research. Several equipment systems were next presented in order to provide insight into the problems associated with their development.

The program on analysis and integration of chemical defense systems is in charge of the meteorology area. Succinctly, the objective of this program is to develop a cohesive system of analytic models and supportive data responsive to the tri-service needs of the user, combat developer, and materiel developer. Evaluation of the effectiveness of such systems is also partially under the responsibility of this program.

Next, Wood outlined the specific needs of CSL in meteorology. The primary interest is in transport and dispersion of chemical agents. Specifically, point concentration, dosage (time integrated concentration), spatial concentration (integrated concentration in space such as along a line of sight), and deposition are the parameters of interest. Modeling of these parameters is needed to assess smoke and obscurant systems, protection systems, local and remote detector response and sensitivity, casualty production and other applications. An aspect of prime concern is that the agents are released by instantaneous sources. This significantly differs from the ordinary situations considered in dispersion modeling. An additional aspect of interest is secondary evaporation of volatile agents. Wood further stressed the dynamic nature of these parameters due to the continuously varying wind and temperature conditions, the wide spectrum of climatological conditions of interest, and the broad range of terrain configuration. Wooded and urban domains in complex terrain are the realistic environments in which the modeling of the dispersion parameters is badly needed. In view of the varying complex terrain and for operational purposes, one further needs to couple the synoptic situation with the specific terrain situation. This coupling is required to adequately evaluate the dispersion parameters for a specific complex terrain under given synoptic conditions. Development of coupled models is essentially the ultimate goal. Generic terrain is commonly used at the present time in modeling. The issue at stake is whether this approach can lead to a realistic complex terrain classification for operational and tactical applications.

Wood next expressed the basic commitment of CSL to the proposed cooperative field study. At the same time, he stressed the need to adequately outline the goals of the joint study. Wood also pointed out that the creation of the database must be conducted according to sound scientific guidelines based on the modeling status. Data should be collected bearing in mind that the target is the modeling. In this regard, one needs to determine the present status of modeling and to outline the improvement avenues.

In concluding the presentation, Wood stressed that the proposed cooperative field study can contribute to solving problems of interest to CSL and reiterated the commitment of CSL to the realization of this joint effort.

### 2.6 Forest Service Reaction to the Cooperative Field Study, W. T. Sommers, Acting Director, Forest Fire and Atmospheric Sciences Research

Sommers started his presentation stating that the Forest Service is faced by the following three basic points with regard to the proposed field study: (1) Does the study fit the needs of FS?; (2) Does the

study represent and contribute to good science?; and, (3) Can the FS fulfill its part of the joint effort? Once these three issues are figured out, the involvement of the FS in the joint study and the MOU between the two agencies follow naturally. In fact, the fire research branch in the FS has a long history of cooperative studies with the Army and other branches of the Department of Defense.

Next, Sommers stressed that the aspect of prime concern are the identification of the scientific output of the field study and the design of the experiment. Collection of data for data sake must be avoided since otherwise this study will be scientifically worthless. To this end, one needs to address the scientific objectives, why collect data, what data to collect, and how to collect the data.

The needs of FS in meteorology and diffusion are basically identical to those of the Army. Both agencies have numerous common objectives and problems as clearly indicated by the previous two presentations. Atmospheric sciences research in the FS is closely tied to fire research. Occurrence of forest fires and fire behavior are largely determined by weather given the fuel and terrain conditions. Smoke transport is an associated aspect of increasing concern in the recent years, in particular, with regard to prescribed burning. Smoke release, penetration and patterns as a result of prescribed burning are essentially similar to the smoke transport aspects of interest to the Army. The FS has also the responsibility for transport of pollutants in wildlands under the Clean Air Act.

Wind and transport models have been and are being developed in the FS, first, to meet the application needs of users and, second for scientific purposes, to better define the physical processes in the atmosphere and the effects of terrain and vegetation on atmospheric flows. The proposed study should, from the FS viewpoint, address the latter set of scientific objectives. Model verification, whose importance is undisputed, should represent only a component of the entire study and should not become its goal. One cannot justify to devote the proposed level of effort solely to model verification. In fact, the FS plans to conduct independently verification of its models as an integral part of the model development program. Sommers next stressed that the cooperative effort should be of high scientific nature dedicated to tying together the effects of canopy, transport and deposition processes, and to integration of meso and micro scale models.

Next, Sommers briefly outlined several basic characteristics of the current FS models. Generally, the model concentrates on mesoscale type of transport with a grid space ranging from 50 to 200 km and a mesh resolution from 500 to 2000 m. The fine mesh resolution is particularly important for the rugged terrain in the West in order not to lose canyons and other significant topographic features. Urban areas are generally not included in the models. Inclusion of urban areas is, however, needed for fire reasons with regard to urban-wildland interaction. The latter is of importance in the West and, particularly, in California. Presently, the modeling effort underway in the FS concentrates on development of a three-dimensional approach to existing two-dimensional models.

A rather strange aspect of the FS modeling effort is that not enough work is devoted to forest canopy airflow and forest meteorology since, historically, most of the meteorological modeling focuses on mesoscale range in support of fire research. The FS needs models and data on canopy flow, including some urban area, and integrated meso-micro scale models as suggested by ASL. A point of prime concern with regard to these objectives is the bridging of the gap between the grid configuration employed in the FS and the canopy scale. It is apparent that due attention should be paid to this aspect in designing the field experiment. In fact, Sommers stressed that the overall design of the field experiment is of crucial significance as far as the scientific level and output are concerned.

In concluding the presentation, Sommers emphasized that the proposed cooperative field study answers the needs of the FS, stressed the importance of clearly defining the objectives and of adequate design of the field experiment, and expressed the commitment of the FS to the joint effort.

## 3. FIELD SITE

Eight tentative field sites were proposed at the First Working Meeting, and G. B. McWilliams (ASL) was charged to conduct an evaluation of these sites according to the criteria that were also advanced at this meeting. The proposed eight sites are: (1) Boise, Idaho; (2) Eugene, Oregon; (3) Huntsville, Alabama; (4) Idaho Falls, Idaho; (5) Little Rock, Arkansas; (6) Los Alamos, New Mexico; (7) Rapid City, South Dakota; and (8) Sacramento/Auburn, California (see Sect. 5.4, Summary Report, First Working Meeting, ASL-CR-83-8035-1, January 1983). All the basic requirements for selection of a field site are listed in Sect. 5.1 of this Summary Report.

McWilliams, to start with, briefly reviewed the criteria for the selection of a field site. The basic requirement is for a site consisting of vegetative and urban domain in moderate complex terrain. A site of a size of about 200x200 km is desired to include mesoscale effects. In selecting the vegetative and urban domains and the complex terrain, one needs to ensure the realization of microscale effects such as airflow within a forest canopy and an agricultural canopy, flow around a single building, flow through a street canyon, flow around a cluster of buildings, valley flows, ridge flows, and drainage flows. The vegetative domain must consist of a large forest canopy with clear edges and clearings, and agricultural canopies, both types of canopy with distinct transition zones. An urban domain composed of an inner city (business district) surrounded by an industrial belt, a residential (or suburban) belt, and rural area-i.e., composed of several land-use categories-is next required. Both the vegetative and urban domains must possess a reasonable upwind fetch so that to ensure the development of fully established flow at the measurement sites. As far as the moderate complex terrain is concerned, a contour gradient of about 700 m/10 km, including valley and ridges, is required. Additional criteria are: (1) acceptable variability of the prevailing meteorological conditions, along with four-season variability; and, (2) relatively defined meteorological and climatological conditions. In addition, the following miscellaneous criteria are to be considered: (1) nearby supporting facilities such as national laboratories, air force bases with weather stations, and universities; and, (2) good road accessibility.

The evaluation of the eight sites was conducted by McWilliams using 1:250000 topographic maps, climatological data supplied by Air Weather Service, meteorological data provided by STAR (joint distribution of wind speed and direction categorized according to Pasquill-Gifford stability classes), city maps and aerial photographs, and general information furnished by the Chambers of Commerce. An evaluation scale consisting of five ranks-viz., excellent, very good, good, fair and poor-was employed to classify the required complex terrain, vegetative domain, urban domain, upstream fetch, meteorological and climatological conditions, and miscellaneous requirements. Next, McWilliams outlined the characteristics of each site and their correspondence to the required

criteria. The ranking of the proposed eight sites according to the evaluation scale is listed below:

1. Sacramento/Auburn, California
2. Eugene, Oregon
3. Los Alamos/Santa Fe/Albuquerque, New Mexico
4. Huntsville, Alabama
5. Little Rock, Arkansas
6. Idaho Falls, Idaho
7. Rapid City, South Dakota
8. Boise, Idaho

Sacramento/Auburn, California, site ranked as following: (1) complex terrain-very good; (2) vegetative domain-very good; (3) urban domain-excellent; (4) upwind fetch-very good; (4) meteorological and climatological conditions-good; and, (5) miscellaneous requirements-excellent. A map (1:1,000,000 DMA Map No. ONCG-18) of the Sacramento area is given in Appendix III. The site of 200 km on the side is in the Sacramento region with the city of Sacramento almost at its center. Generally, the terrain changes smoothly from the western coastal range to moderate complex toward the east. As the Sierra Nevada Mountains are approached, the terrain becomes even extremely complex at the east border of the site. The moderate complex terrain consists of valley and ridges with roughly the desired contour gradient of about 700 m/10 km. Forest canopy with clear edges and clearings, orchards and agricultural canopies are the components of the vegetative domain. The forest canopy consists primarily of coniferous trees, but deciduous trees are also present. Sacramento city is the major urban area within the site. Its population is about 285,000, and the population of the county is about 809,700. Thus, the configuration of the terrain and of the vegetative and urban domains ensures the presence of both macroscale and microscale effects. Moreover, the structure of the vegetative canopies and urban roughness ensures the realization of regional and local scale effects.

The meteorological and climatological conditions of the Sacramento site are quite well defined, except for the seasonal variability as the winter is generally mild and wet, and the spring is relatively short. A wealth of information on the meteorological and climatological conditions of this site is available. Studies of valley winds and drainage flow in the Auburn area, three-dimensional wind near Sacramento city, and land-use for Sacramento, to mention a few, have been performed and published. Other specific studies of wind condition and dispersion of pollutants have been performed by the Research Division, California Air Resources Board (CARB). Additional relevant studies have been conducted by Sierra Cooperative Pilot Project (SCPP), U.S. Bureau of Reclamation, and by North Sonoma County APCD with relation to the air monitoring program at the Geyser geothermal power plant.

As far as nearby support facilities are concerned, two Air Force Bases with weather stations-viz., McClellan and Mather-are located near Sacramento city, and a third Air Force Base-viz., Beale is located near Marysville (about 40 miles north of Sacramento). Additional

nearby support facilities are Lawrence Livermore National Laboratory and University of California at Davis. California Air Resources Board and Sierra Cooperative Pilot Project are additional sources of support in view of their current projects in the Sacramento area. Finally, the road accessibility within the entire site is excellent. In concluding the presentation, McWilliams recommended to select Sacramento area as the field site of the cooperative study.

A great deal of discussion was devoted to the characteristics of the Sacramento area and to the extent to which they meet the prescribed requirements. The ability of the Sacramento site to provide comprehensive data on both macro- and micro-scale effects, along with data at regional and local scale, was stressed. All the participating scientists from both the Forest Service and Atmospheric Sciences Laboratory expressed their support for carrying out the joint field study in the Sacramento area. In view of this consensus, the recommendation of the Second Working Meeting is:

> *"To conduct the cooperative field study in the Sacramento area, California, within a site of 200 km on the side delineated in the map enclosed in Appendix III."*

## 4. PARTICIPATION SURVEY

Prior to convening the second working meeting, a survey form was distributed to all the participants in the First Working Meeting on 18 February 1983. The goals of this survey were: (1) to identify the relevance of current project(s) to and the specific participation in the cooperative field study; and, (2) to collect general information on instrumentation availability and tentative manpower commitment. A sample of this survey form is given in Appendix IV. To date, the survey form has been returned by all the participants except by J. E. Deeming and D. G. Fox. The replies are briefly compiled herein according to the laboratory affiliation and the questions in the survey form. Note that the question number in the survey form is indicated in the summary below for convenience sake.

1. Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico

   6. Current Research: Modeling to define and characterize the micro- and meso-scale conditions within and above vegetative canopies and urban domain, and the boundary layer above complex terrain, and development of a particle diffusion model in open terrain.

   7. Participation: (1) Planning and execution of the field study; (2) Analysis of the database; (3) Measurements and/or characterization of (i) canopy microscale meteorology, (ii) urban microscale meteorology, (iii) complex terrain mesoscale meteorology, (iv) diffusion.

   9. Instrumentation: (1) Canopy domain-at least one 32 m tower instrumented to measure, U,V,W temperature and radiation; (2) Urban domain-to contract for three meteorological towers to be located in the inner city, industrial belt and residential belt; (3) Complex terrain-expect to have a 25 station network with automated weather systems and 4 radiosonde stations.

   10. Instrumentation Cost: Not known at this time.

   11. Manpower: Three persons and radiosonde teams.

2. Chemical Systems Laboratory, Aberdeen Proving Ground, Maryland

   6. Current Research: (1) Characterization of three-dimensional meteorology within and above open, vegetated, urban and complex type terrains; (2) Integration of meteorological factors affecting cloud behavior into a total micro-macro scale structure for a unified meteorological system of terrain features; (3) Incorporation of the unified meteorological system into various chemical, biological, toxin cloud transport and diffusion models.

7. Participation: Through ASL.

9. Instrumentation: None.

11. Manpower: None.

3. Pacific Southwest Forest and Range Experiment Station, Riverside, California

3.1 M. A. Fosberg

6. Current Research: Evaluation of error structure of FS three-dimensional wind model for complex terrain applying Program KRISSY and using the following data bases: (i) ASCOT for the Geyser area: (ii) Santa Ana winds in southern California; and, (iii) marine airflow over the coast range of California.

7. Participation: Deployment of appropriate PSWF&RES instrumentation, supply of personnel to operate and maintain the equipment, and funding to support field activities and data analysis.

3.2 J. E. Bergen

6. Current Research: (1) Joint evaluation of velocity, temperature, shear stress and heat flux profiles over high terrain curvature with a range of surface roughness and heat flux by means of extending a current three-dimensional boundary-layer model to orthogonal curvilinear coordinates; (2) To relate physical canopy structure to the drag coefficient for high vegetation, and to assess the variation of the drag coefficient with stability by separating the transport into dispersion and that due to large scale shear generated turbulence and wake turbulence.

7. Participation: (1) Validation of mesoscale models; (2) To introduce more realistic lower boundary conditions by means of the spatial distribution of the effective surface drag coefficient and its response to stability conditions.

3.3 F. M. Fujioka (did not attend the First Working Meeting)

6. Current Research Relevance: Development of a methodology for planning meteorological networks in complex terrain.

7. Participation: Design of the observation network for the field study.

9. Instrumentation available at PSWF&RES and manpower according to M. A. Fosberg and J. E. Bergen:

(1) Tracking radar; (2) Rawinsonde; (3) Monostatic acoustic sounder; (4) Theodolite-3; (5) Tethersonde; (6) Laser anemometer-2; (7) Surface weather station-6; (8) Micro-barograph-6; (9) Hygrothermograph-6; (10) Wind vector vane-6; (11) Cup anemometer-9; (12) High-volume sampler; (13) CO monitor-2; (14) 16-channel Data Logger-2; (15) VHF communication system.

10. Instrumentation cost: To be specified after completion of the field study detailed planning.

11. Manpower: To be determined according to what instruments will be used and the magnitude of the field study.

4. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado

D. G. Fox:

6. Current Research Relevance: (1) Modeling of mountain circulation systems from local up to a scale of 200 km with particular emphasis on diffusion of pollutants; (2) Evaluation of TAPAS models for airflow and diffusion in complex terrain.

7. Participation: Deployment of RMF&RES instrumentation, supply of personnel to operate and maintain the equipment, and funding to support field activities and data analysis.

9. Instrumentation: (1) Automated theodolite balloon-1; (2) Automated balloon tracking system-1; (3) Tethersonde balloon-1; (4) UVW anemometer-7; (5) Remote Automated Weather Station (RAWS)-4; (6) Monostatic acoustic sounder-1; (7) Data logger-1; (8) Assorted towers and masts.

10. Instrumentation cost: To be specified after completion of field study detailed planning.

11. Manpower: Two scientists and one technician.

5. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon

J. E. Deeming-survey form not yet returned.

6. Intermountain Forest and Range Experiment Station, Northern Forest Fire Laboratory, Missoula, Montana

F. A. Albini:

6. Current Research: Development of algorithms and models for crown fire, surface fire prediction and large fire projection (in conceptual phase) using surface and near surface wind as input.

7. Participation: (1) Design of the field study including instrumentation placement and data specification; (2) Design of data formatting, organization and retrieval; (3) Estimation of forest canopy aerodynamics parameters from stand characteristic data.

9. Instrumentation: None.

11. Manpower: To be determined according to specific cooperative efforts.

7. National Forest System, Equipment Development Center, Missoula, Montana

R. B. Ekblad

6. Current Research: (1) Development of predictive models for deposition and drift of aerially applied spray; (2) Dispersion tests for validation of helicopter and fixed wing spray models.

7. Participation: (1) To provide model predictions of dispersion and deposition of large particles (larger than 75 μm) including effects of gravity, meteorological conditions and aircraft wake; (2) To arrange contracting for aircraft operation, and to supervise layout and collection of deposition samplers.

9. Instrumentation: Tethersonde.

10. Instrumentation cost: No charge without operator.

11. Manpower: Not yet known.

8. National Forest System, Forest Pest Management, Davis, California

J. W. Barry

6. Current Research: Modeling of long range drift of pesticides in mountainous terrain.

7. Participation: (1) Tracer studies and collection of field samples; (2) Modeling of spray and tracer release.

9. Instrumentation: None.

11. Manpower: Two persons.

Examination of the results of this survey indicate that: (1) scientists from both agencies, ASL and FS, plan to actively participate in the cooperative field study; (2) a relatively large amount of instrumentation is available; and, (3) limited manpower is available. It is apparent that one needs to exactly determine the use and deployment of the available equipment, the acquisition of additional instrumentation, if necessary, and the required contractual work according to the specific objectives and the workplan of the field study.

## 5. DELIBERATIONS

The deliberations during the first, second and third sessions concentrated on the scientific objectives and the design of the field study, the need to prepare a comprehensive workplan, the participation in and contribution to the field study of the scientists from the two agencies, and the available and needed resources to conduct the field experiment. A full report of the discussion is not given here since it was conducted in a quite informal manner without accompanying formal presentations. Consequently, only the main points directly relevant to the goals of the working meeting are briefly outlined here.

To start with, a great deal of discussion was devoted to how to relate the development, evaluation and validation of models to the field study. This point was viewed as of crucial significance as far as the scientific level of the field study is concerned. The discussion further focused on the characterization of canopy domain, urban domain and complex terrain, the coupling of micro- and meso-scale ranges needed for the development of integrated models, and on the input data required for testing of models. The need for generic types of canopy domain, urban domain, and complex terrain so that to produce a general database was emphasized. A fair amount of discussion concentrated on the need to conduct diffusion surveys in addition to the basic meteorological measurements. In this regard, it was stressed that the meteorology is independent of diffusion whereas the latter depends on the meteorological conditions. At the same time, it was agreed that both meteorology and diffusion are integral components of the field study and, hence, one needs to design the experiment so that to survey simultaneously their characteristics.

Next, the participants briefly reviewed their current projects relevant to the field study, pointed out their requirements for specific meteorological and diffusion data, and outlined their planned participation in the joint effort. In addition, the participants indicated what instrumentation and equipment are available and the tentative manpower that they can contribute. It was further emphasized that the resources to be provided depend upon the design of the field study. The discussion dealt at the same time with the required measurement techniques to monitor the meteorological and diffusion variables. A list of these variables is given in Sect. 5.2 in the Summary Report on the First Working Meeting. Finally, it was a unanimous consent that the immediate tasks are to clearly state the objectives and to complete the design of the cooperative field study. It was next agreed that the working groups and the scientific and technical committee concentrate their efforts on meeting these pressing goals. One thus can summarize the concluding recommendations of the deliberations as following:

1. *"The Working Groups are charged to define the specific objectives, to complete the design of the corresponding components of the field study, and to outline a detailed workplan."*

2. *"The Scientific and Technical Committee is charged to synthesize the proposals of the Working Groups into a unified set of objectives, an overall design of the field study, and a general workplan."*

3. *"The final proposal should be submitted for approval to the Third Working Meeting in Fall 1983."*

The tentative Technical Working Groups listed in Sect. 5.5 in the Summary Report of the First Working Meeting were restructured as outlined in Sect. 6.

## 6. ORGANIZATION

A great deal of discussion concentrated on the management and organizational structure of the joint field study. The management principles and philosophy outlined in the Summary Report of the First Working Meeting (Sect. 5.5) was approved and provided the background for the discussion. Next, the tentative organizational structure proposed in the First Working Meeting was reviewed. This review focused on the pressing need to ensure a sound overall management and efficient organization of the project. The management and the organizational structure was further discussed in two special meetings held in Fort Collins, Colorado, on 25 April 1983, and in White Sands Missile Range, New Mexico, on 7 June 1983. These two meetings were called to complete the Supplemental Agreement to the Master Memorandum of Understanding between the US Departments of Defense and of Agriculture. Based on the consensus reached in these meetings, an organizational structure was established. This organizational structure, along with the responsibilities of the various committees and their personnel composition, is summarized below:

1. Policy Committee (PC) responsible for setting the policy, guidelines and direction of the joint project, and for arranging and securing the funding and resources for conducting the field study and the model evaluation. This committee consists of: ASL representative E. H. Holt, Chief, Atmospheric Research Division; CSL representative J. D. Wood, Chief, Systems Development Division; PSWF&RES representative E. F. Bell, Assistant Director; RMF&RES representative E. F. Wicker, Assistant Director; Forest Pest Management (FPM) representative F. W. Honing, Assistant Director.

2. Project Manager (PM) responsible for organizing and managing the field study who answers to the Policy Committee. A Project Manager will be appointed prior to the Third Working Meeting planned to convene this coming November.

3. Scientific-Technical Committee (STC) responsible for the overall scientific objectives of the study, the planning and design of the field experiment, and coordination of models evaluation. This committee is chaired by R. M. Cionco, and composed of the following scientists: J. W. Barry, M. A. Fosberg, D. G. Fox, G. B. McWilliams, W. D. Ohmstede, W. Z. Sadeh, and D. W. Sloop. Assistance to STC is to be provided by four working groups in view of the four components of the field study, viz., canopy domain, urban domain, complex terrain, and dispersion. These four working groups are outlined hereinafter.

4. Canopy Working Group (CWG) responsible for specifying the objectives, and conducting the planning and designing of the field study in the canopy domain. This working group is chaired by R. M. Cionco.

5. Urban Working Group (UWG) responsible for specifying the objectives, and conducting the planning and designing of the field study in the urban domain. This working group is chaired by G. B. McWilliams.

6. Complex Terrain Working Group (CTWG) responsible for specifying the objectives, and conducting the planning and designing of the field study in complex terrain. This working group is chaired by M. A. Fosberg.

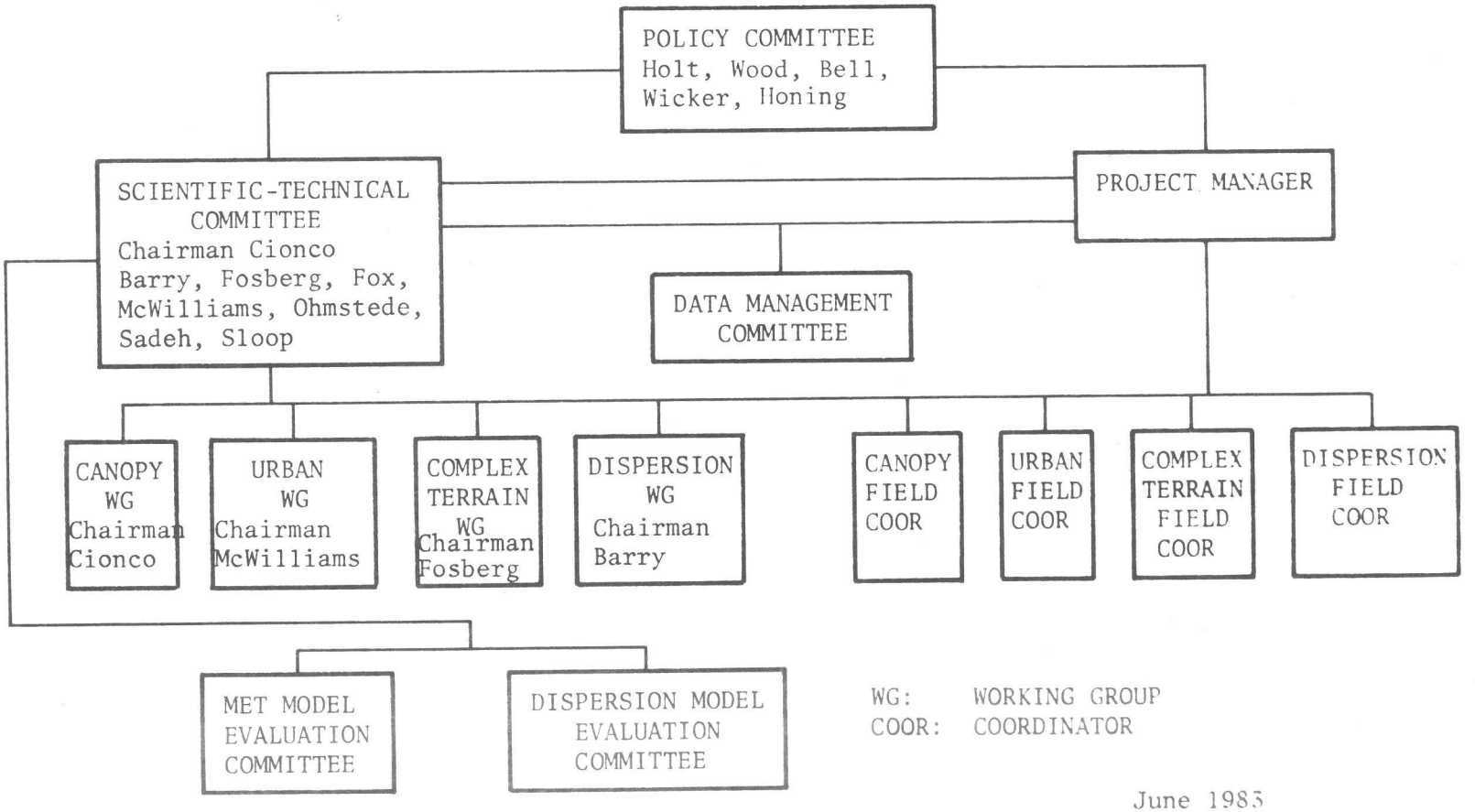
7. Dispersion Working Group (DWG) responsible for specifying the objectives, and conducting the planning and designing of the diffusion and dispersion components of the field study. This working group is chaired by J. W. Barry.

8. Field coordinators (or leaders) for each component of the field study will be selected after the completion of the planning.

9. Data Management Committee (DMC) responsible for development of data management system, and for editing, formatting, archiving and documentation of the database. A database manager will be appointed with the completion of the planning of the field study.

10. Meteorological Modeling Evaluation Committee and Dispersion Modeling Evaluation Committee responsible for conducting the evaluation of models using the database as input. Chairmen of these two committees will be appointed after the completion of the planning of the field study.

A diagram showing this organizational structure is given below. Additional description of the responsibilities of the various committees is provided in the Supplemental Agreement given in Appendix V. With the establishment of this organizational structure, the mission of the Acting Steering Committee is completed.




ARMY-FS Cooperative Field Study Organizational Structure

## 7. SUPPLEMENTAL AGREEMENT

A fair amount of discussion was devoted throughout the entire meeting and, particularly, in Session No. 4 to the required Supplemental Agreement to the Master Memorandum of Understanding between the US Departments of Defense and Agriculture relative to cooperation with respect to research of mutual interest. A supplemental agreement is needed to formalize the cooperative field study between ASL and FS. The supplemental agreement should: (1) outline the objectives and mutual benefits of the cooperative field study; (2) describe the proposed joint research; (3) outline the procedure; (4) establish the management and organizational structure; (5) define the charges to and responsibilities of the various committees, working groups, project manager and field coordinators; (6) state the support and funding requirements; and, (7) indicate the equipment needed to perform the field study.

A quite wide variety of viewpoints and opinions were expressed concerning the content of the supplemental agreement. In order to consolidate all the different points of view into a single document, Philpot was charged to prepare a tentative draft. A special meeting was convened at Colorado State University in Fort Collins, Colorado, on 25 April 1983 to review this tentative draft. The discussions in this special meeting revealed that several significant aspects need further examination. As a result, a Task Force was appointed to complete the drafting of the supplemental agreement. This Task Force consisted of: E. H. Holt (ASL), D. W. Sloop (CSL), C. W. Philpot (PSWF&RES), E. F. Wicker (RMF&RES), J. W. Barry (FPM), R. M. Cionco, D. G. Fox and W. Z. Sadeh (Acting Steering Committee).

A special meeting of the Task Force took place at ASL in White Sands Missile Range, New Mexico, on 7 June 1983. Two slightly different versions of the supplemental agreement, one drafted by ASL and a second by FS, were presented. A thorough examination of the two versions revealed that one can readily consolidate them into a single integrated form acceptable to both agencies. The consolidation was completed and a final form was drafted. Editing of the final version of the supplemental agreement was executed by Philpot. A copy of the Supplemental Agreement is enclosed in Appendix V.

An additional relevant meeting concerning the cooperation between ASL and FS took place at Colorado State University in Fort Collins, Colorado, on 26 April 1983. This meeting was attended by R. Max Peterson, Chief, Forest Service; C. M. Loveless, Director, and E. F. Wicker, Assistant Director for Research, RMF&RES; W. T. Sommers, Acting Director, Forest Fire and Atmospheric Sciences, Forest Service; J. E. Morris, Deputy Director, and E. H. Holt, Chief, Atmospheric Research Division, Army Atmospheric Sciences Laboratory; R. M. Cionco and W. Z. Sadeh, Acting Steering Committee. The basic concept of a cooperative field study between ASL and FS and the mutual benefits of such a joint effort were

briefly outlined by Cionco and Sadeh. Morris expressed the earnest interest of ASL in the cooperative field study. Max Peterson indicated that the Summary Report of the First Working Meeting adequately stresses the pressing need to undertake a joint research effort on meteorological and diffusion characteristics in forest canopies in complex terrain. He next pointed out that the Forest Service needs a comprehensive database as recommended by the First Working Meeting. Finally, Max Peterson stated that the Forest Service supports and will participate in the cooperative field study.

## 8. FUTURE ACTIVITIES

The plan of activities and time table outlined in the Summary Report of the First Working Meeting (Sect. 5.6) was approved. It was further the consensus of the group that all the necessary efforts to comply with this time table must be taken. At this time, the four working groups are charged to complete the proposals on the scientific objectives, planning, design and workplan of the field study as stated in Sect. 6. Meetings of the working groups are scheduled as following:

1. Canopy Working Group at ASL in White Sands Missile Range, New Mexico, on 6 June 1983.

2. Complex Terrain Working Group at California Air Resources Board in Sacramento, California, on 9 and 10 June 1983.

3. Urban Working Group at Forest Pest Management Office in Davis, California, on 1 and 2 August 1983.

4. Dispersion Working Group at Forest Pest Management Office in Davis, California, on 3 and 4 August 1983.

The Scientific and Technical Committee is further charged to synthesize the proposals of the Working Groups into a single integrated proposal prior to the Third Working Meeting as recommended in Sect. 6. A Third Working Meeting will convene at Forest Pest Management Office in Davis, California, from 15 to 17 November 1983. The primary goals of the Third Working Meeting is to finalize the scientific objectives, planning, design and workplan of the cooperative field study. An inspection of the field site is also planned to take place during the Third Working Meeting.

APPENDIX I

ROSTER OF PARTICIPANTS

| Name | Affiliation | Address | Phone |
|---|---|---|---|
| F. A. Albini | Intermountain Forest & Range Experiment Station Northern Forest Fire Laboratory Forest Service | Drawer G Missoula, MT 59806 | (406) 329-3485 FTS 585-3485 |
| J. W. Barry | National Forest Service Forest Pest Management Forest Service | 2810 Chiles Road Davis, CA 95616 | (916) 758-4600 FTS 448-3506 |
| J. E. Bergen | Pacific SW Forest & Range Experiment Station Forest Service | 4955 Canyon Crest Drive Riverside, CA 92507 | (714) 351-6568 FTS 796-6568 |
| R. M. Cionco | Army Atmospheric Sciences Laboratory | DELAS-AR-M White Sands Missile Range, NM 88002 | (505) 678-5210 |
| M. A. Fosberg | Pacific SW Forest & Range Experiment Station Forest Service | 4955 Canyon Crest Drive Riverside, CA 95207 | (714) 351-6568 |
| D. G. Fox | Rocky Mountain Forest & Range Experiment Station Forest Service | 240 W. Prospect St. Fort Collins, CO 80526 | (303) 221-4390 |
| E. H. Holt | Army Atmospheric Sciences Laboratory | DELAS-AR-M White Sands Missile Range, NM 88002 | (505) 678-2412 |
| G. B. McWilliams | Army Atmospheric Sciences Laboratory | DELAS-AR-M White Sands Missile Range, NM 88002 | (505) 678-5210 |
| C. W. Philpot | Pacific SW Forest & Range Experiment Station Forest Service | 4955 Canyon Crest Drive Riverside, CA 92507 | (714) 351-6537 |
| R. A. Rigert | Army Atmospheric Sciences Laboratory | DELAS-AR-M White Sands Missile Range, NM 88002 | (505) 678-4846 |

| Name | Affiliation | Address | Phone |
|---|---|---|---|
| W. Z. Sadeh | Civil Engineering Department Colorado State University | Fort Collins, CO 80523 | (303) 491-8573 |
| D. W. Sloop | Systems Development Division Army Chemical Systems Laboratory | DRDAR-CLY-A Aberdeen Proving Ground, MD 21010 | (301) 671-3570 |
| W. T. Sommers | Forest Fire & Atmospheric Sciences Research Forest Service | P. O. Box 2417 Washington, DC 20013 | (713) 235-8195 |
| J. D. Wood | Systems Development Division Army Chemical Systems Laboratory | DRDAR-CLY-A Aberdeen Proving Ground, MD 21010 | (301) 671-2345 |

APPENDIX II

SECOND WORKING MEETING

ON

METEOROLOGICAL AND DIFFUSION CHARACTERISTICS IN

WOODED AND URBAN DOMAINS IN COMPLEX TERRAIN

Pacific Southwest Forest and Range Experiment Station
Riverside, California
30-31 March 1983

AGENDA

Wednesday, 30 March 1983

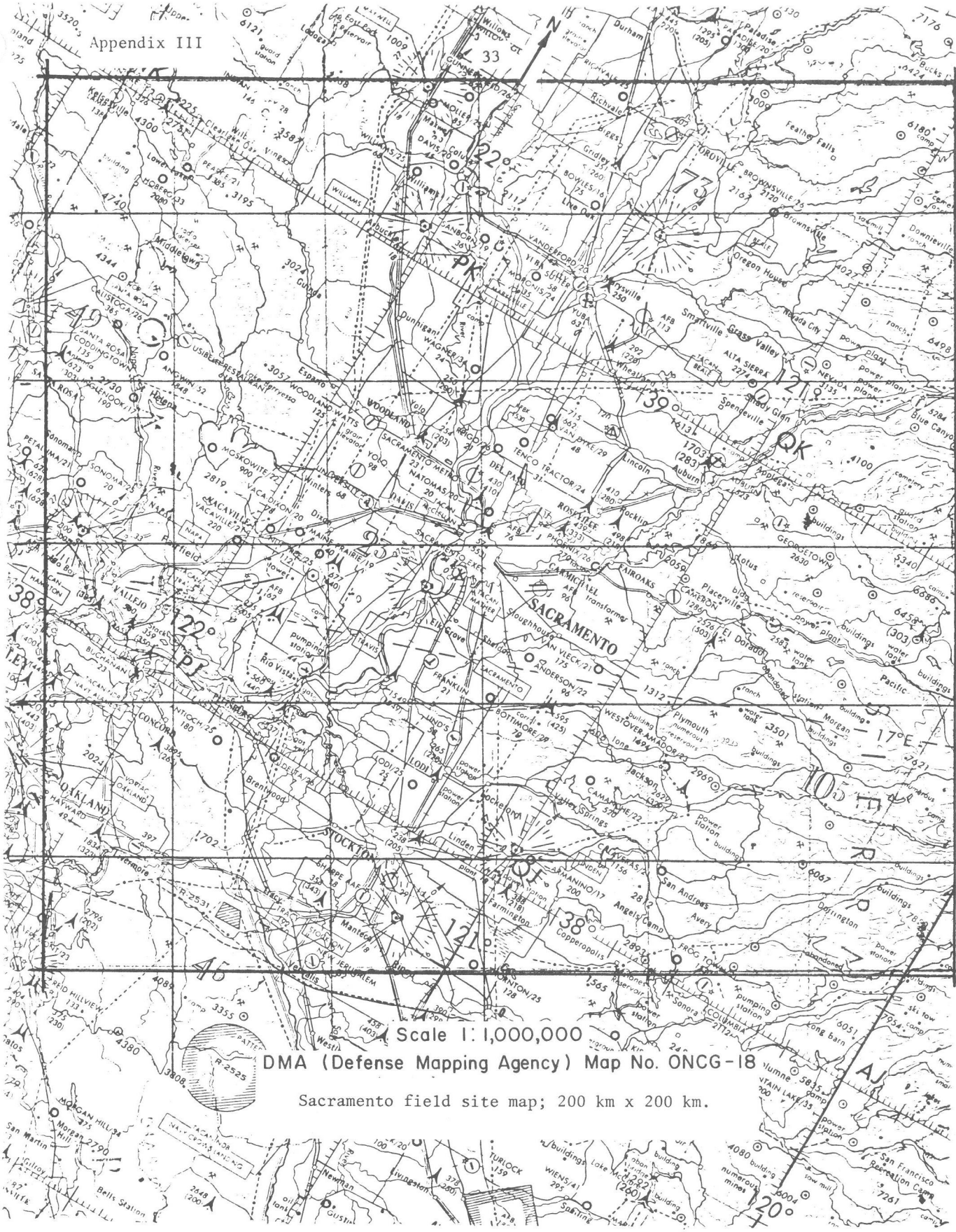
| | |
|---|---|
| Session No. 1 | 8:30 a.m. - 11:45 a.m. |
| Chairman: | M. A. Fosberg, PSWF&RES |
| 8:30 - 8:50 | Forest Service Organization and Activities, C. W. Philpot, Assistant Director, PSWF&RES |
| 8:50 - 9:00 | General Remarks, R. M. Cionco |
| 9:00 - 9:20 | Steering Committee Report, W. Z. Sadeh |
| 9:20 - 9:40 | Atmospheric Sciences Laboratory Reaction to the Cooperative Field Study, E. H. Holt, Chief, Atmospheric Research Division |
| 9:40 - 10:00 | Chemical Systems Laboratory Reaction to the Cooperative Field Study, J. D. Wood, Chief, Systems Development Division |
| 10:00 - 10:20 | Forest Service Reaction to the Cooperative Field Study, W. T. Sommers, Acting Director, Forest Fire and Atmospheric Sciences Research |
| 10:20 - 10:30 | Coffee Break |
| 10:30 - 11:30 | Discussion, W. Z. Sadeh |
| 11:30 | Lunch |

| | |
|---|---|
| Session No. 2 | 1:00 p.m. - 4:00 p.m. |
| Chairman: | D. G. Fox, RMF&RES |
| 1:00 - 2:30 | General Discussion of Army and Forest Service Objectives<br>- Application Objectives<br>- Scientific Objectives |
| 2:30 - 2:40 | Coffee Break |
| 2:40 - 3:30 | Field Site Selection - G. B. McWilliams |
| 3:30 - | General Discussion |

Thursday, 31 March 1983

| | |
|---|---|
| Session No. 3 | 8:30 a.m. - 11:45 a.m. |
| Chairman: | R. M. Cionco, ASL |
| 8:30 - 9:00 | Remarks, R. M. Cionco |
| 9:00 - 9:30 | Resources for Field Study, W. Z. Sadeh |
| 9:30 - 10:00 | Measurements and What You Do With Them, D. G. Fox |
| 10:00 - 10:15 | Coffee Break |
| 10:15 - 11:30 | Data Management, R. M. Cionco, D. G. Fox, W. Z. Sadeh |
| 11:30 | Lunch |
| Session No. 4 | 1:00 p.m. - 4:30 p.m. |
| Chairman: | W. Z. Sadeh, CSU |
| 1:00 - 2:30 | Organizational Structure, Supplemental Agreement |
| 2:30 - 2:40 | Coffee Break |
| 2:40 - 3:15 | Organizational Structure, Supplemental Agreement |
| 3:15 - 3:30 | Future Activities |
| 3:30 - 4:00 | Concluding Remarks, R. M. Cionco, D. G. Fox, W. Z. Sadeh |

Appendix III




DMA (Defense Mapping Agency) Map No. ONCG-18

Sacramento field site map; 200 km x 200 km.

APPENDIX IV

SURVEY FORM

COOPERATIVE FIELD STUDY

US ARMY ATMOSPHERIC SCIENCES LABORATORY AND US FOREST SERVICE

The goal of this survey is to collect data needed for completing the initial planning of the proposed cooperative field study between the US Army Atmospheric Sciences Laboratory and US Forest Service. At this point, one needs data on:

(1) your current research project(s) and their relevance to the field study;

(2) how you foresee your participation in the field study;

(3) instrumentation that you can provide for use in the field study;

(4) manpower that you can commit for the field study.

A questionnaire is enclosed to gather this data in a standard format. Your answering all the questions is imperative for completing the planning of the Second Working Meeting. Please return this questionnaire to Dr. W. Z. Sadeh by March 10, 1983. Thanks in advance for your help.

February 1983

QUESTIONNAIRE

I. Personal Data

1. Name _____

2. Position _____

3. Affiliation _____

4. Address _____

5. Telephone _____

II. Current Research and Participation

6. Short statement concerning the relevance of your current project(s) to the cooperative field study (if more space is needed, attach separate sheet of paper).

7. Short statement concerning your direct participation in the cooperative field study. Please be specific on your participation.

III. Instrumentation

8. List instrumentation that you can provide and fill out a form for each instrument according to the enclosed format.

9. List instrumentation that you can supply for each phase of the field study cycle, see Report on Working Meeting, p. 17.

   9.1 Fall 1984

   9.2 Winter 1985

   9.3 Spring 1985

   9.4 Summer 1985

10. Cost of using your instrumentation, if any. List charge per instrument per day.

    10.1 Fall 1984

    10.2 Winter 1985

    10.3 Spring 1985

    10.4 Summer 1985

---

Attach separate sheet of paper if more space is needed.

IV. Manpower

11. Manpower that you can commit including cost for each phase of the field study cycle. List cost per individual per day.

11.1 Fall 1984

11.2 Winter 1985

11.3 Spring 1985

11.4 Summer 1985

INSTRUMENT FORM

1. Instrument

2. Variable(s) to be measured

3. Maker

4. Type

5. Model

6. Power requirements

7. Characteristics

8. Input signal

9. Output signal

10. Type of recording

11. Data logger

12. Accuracy

13. Resolution

14. Enclose copy of manufacturer's specifications

APPENDIX V

SUPPLEMENTAL AGREEMENT TO THE MASTER MEMORANDUM OF UNDERSTANDING
BETWEEN
UNITED STATES DEPARTMENT OF DEFENSE
AND
UNITED STATES DEPARTMENT OF AGRICULTURE
RELATIVE TO COOPERATION WITH RESPECT TO
FOOD, AGRICULTURE, AND OTHER RESEARCH
OF MUTUAL INTEREST

SUBJECT: Evaluation of Mesoscale and Microscale Meteorological, Airflow, Dispersion, and Deposition Models in Forest, Agricultural, and Urban Environments

I. PROBLEM: Many sophisticated mathematical models have been developed to describe and predict meteorological phenomena and processes. These models deal with wind and turbulence characteristics, temperature, humidity, dispersion and deposition of airborne materials. They have been routinely used by DoD and USDA scientists and managers to predict meteorological conditions. Most of these models have had inadequate evaluation in the field because there is a lack of environmental information in both the microscale and mesoscale ranges that simultaneously includes airflow over and within various vegetative canopies, urban areas, and complex terrain. An integrated, multiagency effort is required to develop such information because a single organization does not have the required fiscal and personnel resources. Until such cooperation is developed, the meteorological, dispersion and deposition models cannot be evaluated, refined, and implemented for practical use and operational decisionmaking.

II. GENERAL OBJECTIVES: The objective of this joint effort is to develop integrated environmental information on meteorological, dispersion and deposition processes for the evaluation and improvement of models that describe wind, turbulence, temperature, humidity, dispersion, concentration, drift and deposition over and within forest, agricultural, and urban domains in complex terrain.

III. SPECIFIC OBJECTIVES: The specific objectives of this cooperative effort are to evaluate and improve:

- selected mesoscale meteorological models of windspeed and direction, turbulence, temperature, and humidity in complex terrain.
- selected microscale models of windspeed and direction, turbulence, temperature, and humidity above and within forest canopies, agricultural crops, and urban areas.
- models that predict dispersion, concentration and pattern of small particulates, droplets, and gases.
- models that predict drift and deposition of small particulates and droplets.
- model performance by identifying and investigating critical elements and processes of selected models.

IV. SCOPE; The scope of this work includes the design, implementation, and conduct of meteorological, dispersion, and deposition field studies within and above forest canopies, agricultural canopies and complex terrain in support of test and evaluation of meteorological, dispersion and deposition models.

V. PROCEDURE: The projected length of this cooperative effort is three years beginning October 1, 1983. This agreement will be extended, rewritten or modified during FY 86 if additional formal cooperation is warranted. About 6 months of preplanning has been accomplished in FY 83. The planning phase of the project will continue throughout FY 84. The field study will begin in FY 85 and will include four data collection periods of several days each in the Sacramento area, California. This will be followed with one year of data reduction, assessment, archiving, documentation, and model evaluation.

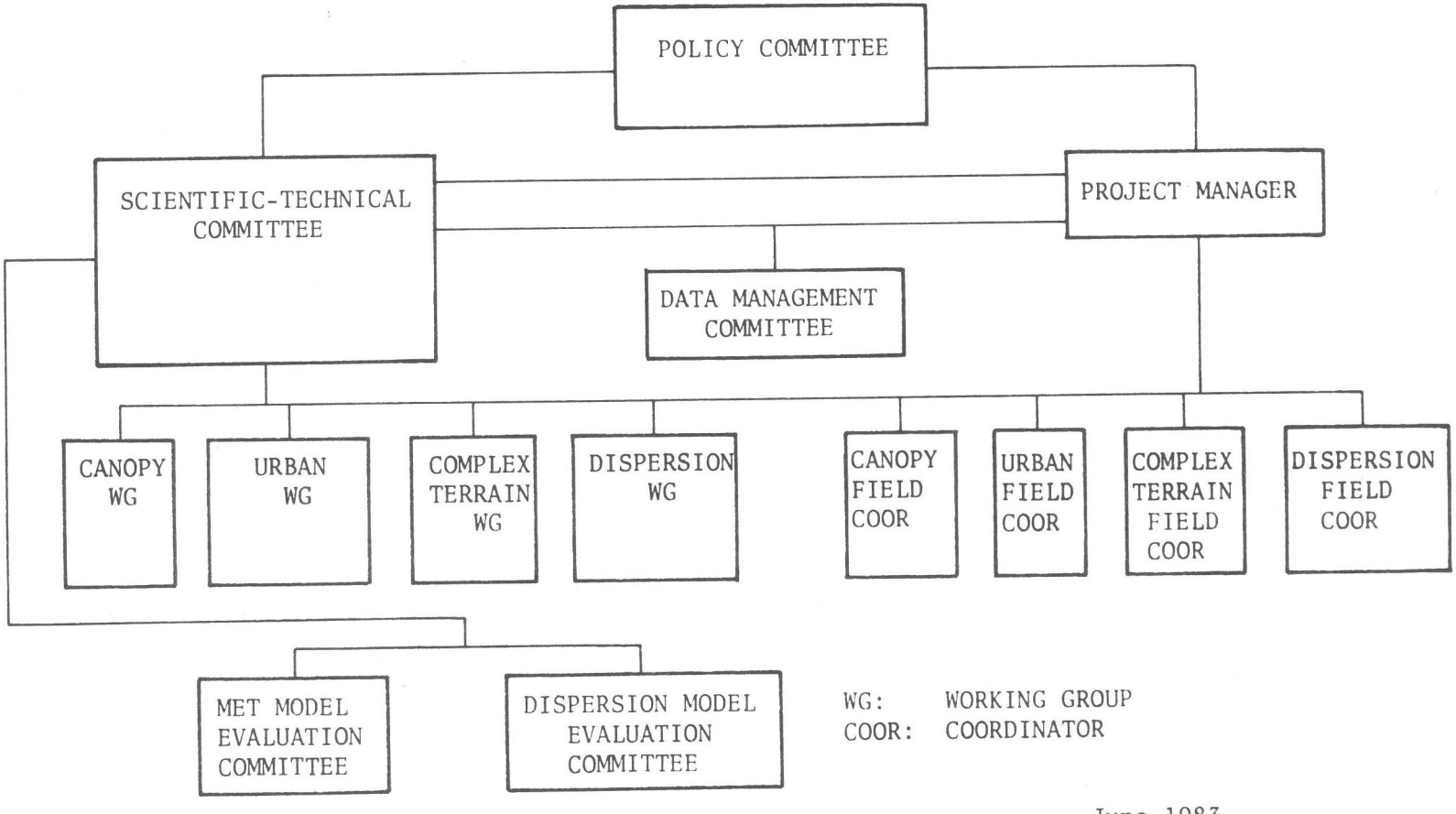
The study area to be sampled and characterized is 200x200 km and contains forests, crop canopies, a moderate urban area, and complex terrain. The DoD and USDA organizations and their contractors will provide the field equipment and instrumentation required for their respective field work and data management. This cooperation will encourage the exchange of personnel and equipment to insure the best possible product. All field work will be conducted in such a manner that all data will be unclassified.

A research plan will be designed and formalized by a group of select DoD-ASL and USDA-FS scientists that have specific interests in meteorological, dispersion and deposition processes within and above vegetation and urban domains in complex terrain. A Scientific-Technical Committee (STC), composed of principal Army and Forest Service scientists and other scientists, will design the field experiment. The Chairman of the STC is responsible for providing a mutually acceptable plan of research for Policy Committee approval and Project Manager implementation. Four working groups are designated to assist the STC Chairman by designing specific components of the cooperative field study and model evaluations. These groups are the Canopy Working Group (CWG), Urban Working Group (UWG), Complex Terrain Working Group (CTWG), and Dispersion Working Group (DWG).

The organizational structure required to implement the research plan, manage the field study, and evaluate models will be composed of groups for planning and analysis, direction, and operations. A block diagram of the organizational structure is given below. The Policy Committee may at anytime add to or modify the organizational structure.

Definitions of Each Group Follow:

Policy Committee: This committee is composed of one representative from each organization contributing resources to the study. This committee sets policy, arranges funding, and holds the Project Manager accountable for meeting




ORGANIZATIONAL STRUCTURE OF ARMY-FS COOPERATIVE FIELD STUDY

field and evaluation study objectives. The USDA will be represented by Assistant Directors of participating Experiment Stations and Forest Pest Management. DoD will be represented by the Chief of Atmospheric Research Division from ASL and the Chief of Systems Development Division from CSL.

Project Manager: This individual is responsible for organizing, assembling, and managing the resources needed to meet the field and evaluation study objectives. The Project Manager responds to policy and direction received from the Policy Committee. Study design and technical direction comes from the STC. The Project Manager is responsible for field installation of equipment and operation during the study periods. He is further responsible for coordinating the acquisition of the database, the integration of the database in a unified system, development of additional cooperation, and dealing with landowners at the field site.

Scientific-Technical Committee: This committee is composed of principal DoD and USDA scientists participating in the field study and other scientists. The Chairman is responsible for providing a mutually acceptable study design to the Policy Committee for the Project Manager to execute and for insuring that model evaluation is performed. Four working groups will assist the Chairman of STC to design the specific components of the field study, i.e., the Canopy Working Group, Urban Working Group, Complex Terrain Working Group and Dispersion Working Group.

Database Committee: This committee is composed of principal DoD and USDA scientists participating in the Field study and other scientists. The Chairman of this committee will act as database manager and he is responsible for supplying the design, plan, and implementating procedure of a data management system for the entire field and model evaluation study. This system must synthesize the individual data acquisition methods. The total database must be edited, formatted, documented, and archived such that all field and model evaluation participants can access and use the entire database.

Canopy Study Leader: This individual is responsible to the Project Manager for the field operation in forest and agricultural canopies during the study periods.

Urban Study Leader: This individual is responsible to the Project Manager for the field operation in the urban area during study periods.

Complex Terrain Study Leader: This individual is responsible to the Project Manager for the field operation in complex terrain and mesoscale studies during the field experiment.

Dispersion Study Leader: This individual is responsible to the Project Manager for the field operation for the dispersion of gases, liquids, and particles within and above canopy and urban domain and above complex terrain during the field study periods.

The management procedure will be for the STC to determine the study design and data requirements during FY 83 and 84. The Project Manager will start his work by November 1, 1983, and begin preparing for the field work which begins in October 1984. The Project Manager will also develop cooperation with additional groups and secure existing database and studies of Sacramento region during FY 84.

VI. EXPECTED BENEFITS: The joint study will generate a unique comprehensive meteorological database of high priority need to both USDA and DoD. The DoD will use the database to evaluate and modify models that predict windspeed and direction, turbulence, dispersion and deposition of particulates and aerosol materials that impair visibility or otherwise interfere with battlefield tactics and operations above and within forest canopies, agricultural crops and urban areas in complex terrain.

The USDA will use these data to evaluate the potential usefulness of several existing meso/micro scale models in fire suppression, smoke management, prescribed burning predicting pesticide dispersal, drift, and deposition; air quality assessment, and predicting transport, dispersion and deposition of air pollutants.

Generation of this comprehensive information is practical only through the combined efforts of both Departments because neither has currently allocated the necessary resources and personnel to achieve this goal independently. This agreement will make possible to obtain the database at essentially the same independent level of investment and, in fact, make a more efficient use of current resources and available personnel. This agreement will insure that both Departments can evaluate models of complex meteorological and dispersion processes much quicker, efficiently and at a level of intensity unlikely within separate programs.

VII. SUPPORT REQUIREMENTS: The following support requirements are identified or projected. Changes by the Policy Committee may be appropriate during the planning phase. More resources will become available if additional cooperators join this effort. The total fiscal support for the USDA and DoD portions of this study will be about $3 to 4.5 million over a 3-year period. Should an exchange of funds become necessary, this will be accomplished through individual funding agreements. The Policy Committee will identify an annual budget at the beginning of each fiscal year.

A. Personnel

| | (portion of time per FY) | | |
|---|---|---|---|
| | FY 84 | FY 85 | FY 86 |
| Project Manager | 1.00 | 1.00 | 1.00 |
| Canopy Field Study Leader (A) | .25 | .75 | .50 |
| Urban Field Study Leader (A) | .25 | .75 | .25 |
| Complex Terrain - Mesoscale Study Leader (FS) | .50 | 1.00 | .50 |
| Dispersion Study Leader (FS) | .50 | .85 | .50 |
| Database Manager | .50 | 1.00 | 1.00 |
| Chairman STC (A) | .50 | .75 | .50 |
| Working Groups (A&FS) | | (as needed) | |
| Field Technicians (A&FS) | .25 | Full time during each study period | |

A = Army
FS = Forest Service

B. Equipment The required field equipment and meteorological and dispersion sensors and collectors will be identified and defined by the various working groups of the STC during FY 83.

VIII. RESPONSIBILITIES: The Project Manager is responsible for public information, liaison with landowners, impact statements, and safety. DA and USFS will jointly publish a comprehensive database in a standard format fully documented and archived. All other publications will be the responsibility of the individual scientists and their respective organizations or the various working groups. Contracts may be implemented independent of each other if the work is required by only one organization. The lead laboratory for that subject can coordinate with the other laboratories as required.

Signed

| Concurrence | Approval |
| --- | --- |
| Department of the Army: | |
| _____ | _____ |
| Director - ASL | Chief - Forest Service |
| _____ | |
| Director - CSL | |
| USDA Forest Service: | |
| _____ | _____ |
| Director - RM | Commander - ERADCOM |
| _____ | _____ |
| Director - PSW | Commander - ARADCOM |
| _____ | |
| Director - FPM | |

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